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PYROLYTIC PROPERTIES of Alberta Coals

by S.K. Chakrabartty,
J.F. Fryer and J.D. Campbell

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ABSTRACT

Alberta coals differ in their responses to low temperature carbonization treatment. Either Fischer-Schrader or Gray-King assay methods are suitable for the rapid assessment of different coal deposits. Thirty-four Alberta coals are assessed here and their pyrolytic properties are reported. Chemical mechanisms of pyrolysis are discussed in the light of the reported data. High volatile bituminous coals appear to be the most suitable for low temperature carbonization processing.

INTRODUCTION

Pyrolysis is a chemical reaction, initiated by heat in complete or partial absence of air, which results in structural fragmentation of chemical units.

When coal is pyrolyzed, it yields four commonly recognized classes of product: solid residues (either cokes or chars), heavy organic liquids (tars and oils), watery liquid (liquor), and gas. The characteristics and the distribution of the products yielded vary with the coal and are considered to define the pyrolytic properties of that coal.

Two kinds of coal carbonization processes are commonly recognized: high temperature carbonization (HTC) with temperatures about 950°C; and low temperature carbonization (LTC) with temperatures about 550°C.

Product distributions vary with reaction temperatures; in general, LTC methods yield a wider, more easily characterized variety of products than HTC methods and are therefore more useful in rating coals according to their usefulness as process feedstocks.

The earliest LTC tests on Alberta coals were made by the Fuel Research Laboratories of the Bureau of Mines at Ottawa, over a period of many years, using 2 to 3 kg samples heated in a retort in a molten lead bath to 600°C. Stansfield and Lang (1944; p. 69) have summarized the results of seventeen of these tests, made between 1919 and 1928: ten from the mountains region and seven from the plains.

After World War II, there was a revival of interest in coal carbonization, especially in the use of the fluidized bed carbonizer (see Moreland, 1958). From 1958 to 1960, the Alberta Research Council carried out a series of tests to determine the suitability of representative coals drawn from all major producing areas of the province; the samples included bituminous as well as subbituminous coals. The results, published by Davies, Moreland and Berkowitz (1961), are discussed below.

Currently, with the worldwide energy crisis, there is a revival of interest in the use of coal as a source of energy and as a feedstock for chemical industry. The Alberta Research Council recently initiated a five-year coal conversion research program. This program has the two-fold aim of encouraging wide and efficient use of Alberta's coal in existing processes and, at the same time, of developing new processes and concepts. As part of this new program, the province's coal deposits need to be screened according to their suitability for the various processes.

This document records a series of tests carried out in continuation of the work begun by Davies, Moreland and Berkowitz (1961), screening the province's coals according to their response to the rigorous thermal treatment which is a major component of most coal technology; in other words, recording the pyrolytic properties of Alberta coals.

ALBERTA COALS

Coal measures underlie more than one-third of the total area of Alberta, or about 94 700 square miles. More than 90 percent of this coal lies in the plains region and the remainder in the Rocky Mountains and foothills regions. Mineable coal is found in two major stratigraphic horizons: (a) the Lower Cretaceous (Kootenay, Luscar and equivalent Formations, largely restricted to the mountains region); and (b) the Upper Cretaceous and Lower Tertiary (Belly River, Horseshoe Canyon, Scollard and equivalent Formations; found in both foothills and plains regions).

Coal rank (ASTM) decreases systematically with increased distance east and northeast from the axis of the Rocky Mountains so that the mountains region coals vary from semi-anthracite to high volatile B bituminous, the foothills coals are mostly high volatile C bituminous, and plains coals vary from high volatile C bituminous to lignite A (see figure 1).

Coking properties are restricted to coals of the mountains region.

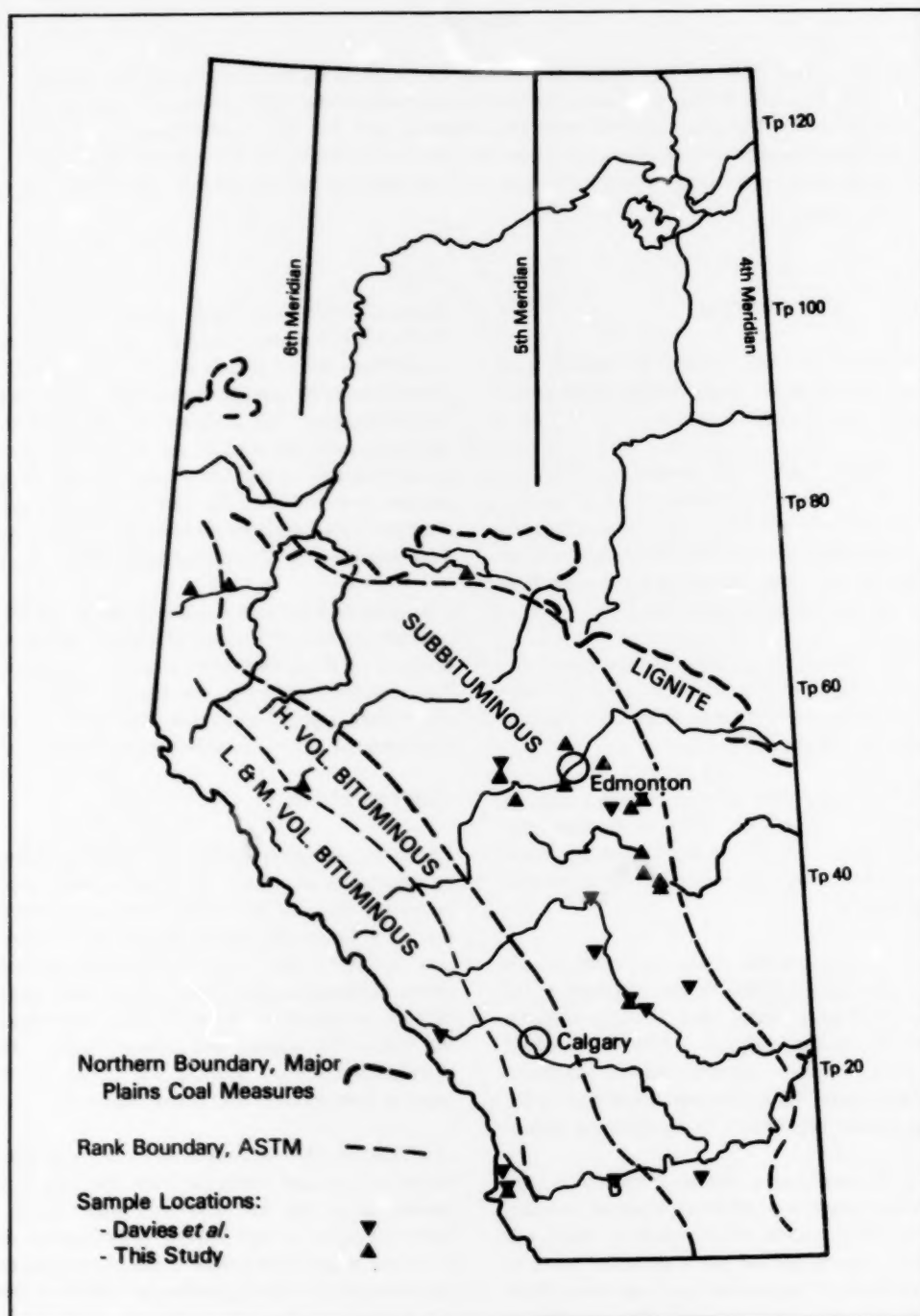


FIGURE 1. Map of coal pyrolysis sample locations

TEST SAMPLES

Thirty-nine of the fifty-one samples whose pyrolysis assays form the basis of this report have been selected from an Alberta Research Council coal type-sample collection, assembled intermittently through the 1950s. Each sample in this collection, stored in a small sealed container, is usually from a channel-sample cut from the top to the bottom of a fresh mine face and represents as closely as possible the normal output of the mine. The fifty-one samples fall into four groups:

1. sixteen samples from the Alberta Research Council coal type-sample collection, assayed and reported previously by Davies *et al.* (1961) with identities and provenances indicated in table 1 and on the map, figure 1;
2. twenty-three samples from the same collection, assayed and reported in this paper for the first time; with identities and provenances indicated in table 2 and figure 1;

3. six samples collected February 27, 1981 from seams no. 1 and 2 (the closely associated main seams), Highvale Mine, in Sec 7 Tp 52 R 4 W5 Mer, assayed separately and in various combinations and catalogued in table 3;

4. six Alberta samples of essentially unknown provenance, assayed for comparison testing of methods, randomly selected from many samples received in 1980 from various coal exploration programs and operating coal mines, and catalogued in table 4.

ASSAY TECHNIQUE

There is no internationally recognized standard procedure to evaluate pyrolytic properties of coals. Fischer and Schrader (1920) designed an apparatus which was adopted by the United States Bureau of Mines and the American Gas Association in 1928 to survey the carbonization properties of American coals. Gray and King (1923) designed a similar apparatus for the Fuels Board of Great Britain to study the pyrolytic properties of British coals.

TABLE 1a.

Coal Pyrolysis Data from Davies *et al.* (modified Fischer-Schrader apparatus; 800°C): Coal and Product Characterization.

Sample Provenance:			Rank		(% dry, ash-free)		Dry Ash% *	Capacity Moisture% *	(Percent Total Organics of Coal) **			
Locality	Tp	R	Mer	ASTM	C *	H *			Char	Tar + Liquid Oil	Liquor	Gas
Canmore	24	10	5	L v Bit	91.3	3.7	9.6	1.5	87.3	3.9	3.0	5.5
Coleman	8	4	5	M v Bit	87.4	5.1	9.6	2.0	79.3	9.7	3.3	7.7
Blairmore	8	4	5	M v Bit	86.5	5.1	11.0	2.2	75.1	12.4	4.2	8.3
Galt. No. 8	9	22	4	H v. C Bit	78.7	5.5	9.6	10.7	67.6	10.8	10.1	11.5
Trochu	33	23	4	Sub. A	77.6	5.0	12.5	17.4	67.4	7.7	13.0	11.9
Alix	39	23	4	Sub. B	77.0	4.9	10.5	19.8	67.4	6.6	12.5	13.5
East Coulee	27	18	4	Sub. B	76.4	4.9	7.4	18.0	66.0	5.6	12.2	16.2
Wabamun	53	4	5	Sub. B	76.4	4.9	14.6	19.3	66.0	7.3	12.2	14.5
Wayne	28	20	4	Sub. B	76.3	5.1	11.0	18.8	63.8	9.5	13.6	13.1
Grassy Lake	9	13	4	Sub. B	76.2	5.2	11.8	18.5	66.5	9.8	11.2	12.5
Ellerslie	51	25	4	Sub. B	76.2	5.0	10.7	23.3	64.4	7.2	14.7	13.7
Dinant	48	19	4	Sub. C	74.9	5.0	9.2	28.4	64.6	7.9	13.0	14.5
Halkirk	40	15	4	Sub. C	74.7	5.1	6.9	26.4	62.4	8.9	13.6	15.1
Forestburg	40	15	4	Sub. C	74.7	5.0	6.8	29.4	62.8	6.5	15.2	15.5
Ryley	49	17	4	Sub. C	74.5	4.9	10.3	28.1	61.6	7.7	15.4	15.3
Sheerness	29	13	4	Sub. C	73.6	4.9	8.9	27.5	60.6	7.8	13.5	15.1

* data from unpublished ARC files

** data from Davies *et al.* (1961)

TABLE 1b.
Coal Pyrolysis Data from Davies *et al.* (1961): Pyrolysis Gas Composition

Sample Locality	Gas Yield, mL/100 g daf coal*	Calorific Value Btu/cu ft	(Percent of Total Gas Produced)						
			Hydrogen	Carbon monoxide	Carbon dioxide	Methane	Ethane	Propane	Ethylene
Canmore	10 244	694	37.5	4.4	3.9	53.3	0.9	-	-
Coleman	9 042	735	35.0	4.5	2.3	56.1	2.1	-	-
Blairmore	10 009	740	34.6	3.9	3.2	55.2	3.1	-	-
Galt. No. 8	12 292	580	20.2	13.3	22.3	41.3	2.9	-	-
Trochu	13 131	524	26.2	14.7	21.7	35.9	1.5	-	-
Alix	13 579	508	21.4	16.8	25.0	35.1	1.6	-	-
East Coulee	15 940	492	23.1	14.1	27.5	33.5	1.8	-	-
Wabamun	15 138	446	25.5	13.2	30.7	29.2	1.4	-	-
Wayne	14 096	520	23.0	13.5	25.4	36.1	2.0	-	-
Grassy Lake	13 445	564	22.2	13.5	22.2	39.3	2.6	-	0.2
Ellerslie	14 357	504	23.3	15.3	25.5	33.9	1.8	-	0.2
Dinant	14 859	485	22.2	16.4	27.2	32.5	1.7	-	-
Halkirk	15 967	495	24.7	13.7	26.6	33.0	1.8	-	0.2
Forestburg	15 049	471	21.4	16.1	29.2	31.8	1.5	-	-
Ryley	15 144	476	23.0	14.6	29.2	30.9	2.1	-	0.2
Sheerness	15 059	477	23.6	14.6	29.2	30.9	2.1	-	0.2

* including N₂ and O₂.

TABLE 2.
Pyrolysis Data of Alberta Coals (Gray-King Assay):
Coal and Product Characterization

Sample Provenance			Rank	Mer	ASTM	(% Dry, ash-free)		Dry Ash%	Capacity Moisture%	(Percent Total Organics of Coal)				Gas Calorific Value	
Locality	Sec	Tp				C	H			Char	Tar + Liquid Oil	Liquor	Gas	Btu/cu ft	
Blairmore	2	8	4	5	M v Bit	88.0	5.6	15.7	1.6	80.1	11.2	3.5	5.2	627	
Grassy Mt.	23	8	4	5	M v Bit	87.5	5.6	18.5	1.8	80.6	10.9	2.9	5.6	607	
Hinton 1	29	50	25	5	H v A Bit	84.2	5.2	22.7	-	72.6	12.2	5.5	9.7	546	
Hinton 2	29	50	25	5	H v A Bit	84.2	5.2	22.7	6.8	75.5	16.5	0.7	7.3	630	
Redwillow	24	70	11	6	H v C Bit	79.6	5.2	6.2	12.2	69.9	13.8	6.8	9.4	610	
Gde. Prairie	35	70	7	6	Sub. A	78.5	5.1	8.9	17.5	71.4	11.5	7.0	10.1	600	
Warburg	13	49	3	5	Sub. B	76.7	4.9	9.4	18.4	67.9	9.3	9.7	13.1	-	
Wayne	18	28	19	4	Sub. B	76.4	5.1	6.8	18.0	67.1	10.9	9.7	12.3	477	
Ellerslie 1	26	51	25	4	Sub. B	75.7	5.0	5.5	23.4	66.3	12.3	7.6	13.8	417	

TABLE 2. (continued)

Sample Provenance			R	Mer	Rank ASTM	(% Dry, ash-free)		Dry Ash%	Capacity Moisture%	(Percent Total Organics of Coal)				Gas Calorific Value	
Locality	Sec	Tp				C	H			Char	Tar +	Liquid Oil	Liquor	Gas	Btu/cu ft
Ellerslie 2	25	51	25	4	Sub. B	75.7	5.0	8.2	22.3	65.9	10.2	9.4	14.4	402	7
Heisler 1	33	42	17	4	Sub. C	75.1	5.1	11.2	24.5	65.5	11.1	9.9	13.5	395	
Heisler 2	7	43	17	4	Sub. C	74.9	5.1	6.3	26.0	63.7	10.8	10.6	14.9	451	
Heisler 3	22	42	17	4	Sub. C	74.8	5.0	10.9	25.2	67.7	9.4	6.2	16.7	460	
Heisler 4	22	42	17	4	Sub. C	74.7	5.2	15.7	23.1	65.0	9.9	8.0	17.1	440	
Meeting Ck.	28	41	17	4	Sub. C	74.6	4.9	10.3	24.7	62.7	12.1	6.1	17.2	454	
Halkirk	2	41	16	4	Sub. C	74.4	5.2	7.4	26.5	63.4	9.8	11.1	15.7	397	
Blackfoot I.R.	12	21	21	4*	Sub. C	74.3	5.0	9.0	17.7	64.7	10.7	10.5	14.1	-	
Ryley	8	49	17	4	Sub. C	74.0	4.7	8.3	29.3	64.2	10.3	8.7	16.8	425	
Namao	6	55	24	4	Sub. C	73.9	5.1	13.8	24.0	64.3	9.1	11.4	15.2	450	
Forestburg	32	40	15	4	Sub. C	73.8	5.1	11.1	24.9	64.0	10.6	9.1	16.3	455	
Dusty Lake	15	48	18	4	Sub. C	73.4	4.8	7.0	29.2	65.0	7.8	11.5	15.7	-	
Ardrossan	2	53	21	4*	Lig. A	72.0	4.9	11.2	28.4	62.4	10.1	9.6	17.9	455	
Sawridge	22	73	8	5	Lig. A	71.6	4.8	9.6	35.2	61.6	8.6	8.6	21.1	380	

* Site glacially disturbed; some analyses anomalous.

TABLE 3a.
Pyrolysis Data of Highvale Mine Coal (Fresh Channel Sample):
Coal and Product Characterization
Location - Sec 7 Tp 52 R 4 W 5th Mer
Rank, ASTM - Subbituminous B
Assay - Gray-King

Component Samples		(% Dry, ash-free)		Dry Ash%	Capacity Moisture%	(Percent Total Organics of Coal)			Gas
		C	H			Char	Tar +	Liquid Oil	
a.	Seam 1: top third	74.4	4.49	19.5	18.4	68.8	8.3	6.7	16.2
b.	Seam 1: mid third	75.3	4.41	10.1	19.6	70.3	7.1	6.5	16.1
c.	Seam 1: bottom third	74.9	4.40	10.3	19.4	69.8	8.3	8.4	13.5
d.	Seam 2: top third	74.9	4.41	15.0	19.5	68.1	6.5	7.7	17.7
e.	Seam 2: mid third	75.3	4.44	10.5	20.0	68.9	6.8	8.7	15.6
f.	Seam 2: bottom third	74.8	4.54	7.7	19.6	69.4	7.7	7.7	15.2
g.	Seam 1: equal blend, 3 samples	75.0	4.50	13.1	19.1	70.4	5.4	7.9	16.3
h.	Seam 2: equal blend, 3 samples	74.8	4.33	11.1	19.4	69.2	6.1	8.4	16.3
j.	Seams 1 & 2: equal blend, 6 samples	75.1	4.46	10.7	19.6	69.5	6.6	7.9	16.0

TABLE 3b.
Pyrolysis Data of Highvale Mine Coal (Fresh Channel Sample):
Pyrolysis Gas Composition

Component Samples	Gas Yield, mL/100 g daf coal*	(Percent of Total Gas Produced)						
		Hydrogen	Carbon monoxide	Carbon dioxide	Methane	Ethane	Propane	Ethylene
a.	15690	20.4	15.1	31.8	22.7	1.6	0.5	0.2
b.	15076	18.5	16.8	32.5	23.9	1.6	0.5	0.3
c.	13122	17.5	15.1	29.9	27.1	1.8	0.6	0.3
d.	16523	21.6	14.6	34.7	21.8	1.5	0.5	0.2
e.	15616	20.9	13.8	30.6	26.2	1.7	0.5	0.3
f.	15689	21.6	14.3	27.6	27.3	1.7	0.5	0.3
g.	15274	18.2	13.1	34.1	25.0	1.7	0.6	0.3
h.	15751	19.9	15.6	31.1	23.5	1.6	0.6	0.2
j.	15245	19.9	15.2	30.2	25.4	1.7	0.6	0.3

*including N₂ and O₂.

TABLE 4a.
Pyrolysis Data of Alberta Coals, Provenance Unknown (Gray-King assay):
Coal and Product Characterization

Sample Designation	(% Dry, ash-free)		Dry Ash%	Capacity Moisture%	(Percent Total Organics of Coal)			
	C	H			Char	Tar + Liquid Oil	Liquor	Gas
A.	73.9	3.7	9.2	23.2	66.3	5.1	8.9	19.7
B.	74.5	4.3	17.4	18.9	70.3	3.5	8.8	17.4
C.	77.7	5.3	13.3	12.8	65.5	12.1	9.4	13.0
D.	72.8	4.5	10.6	23.3	72.9	6.0	1.0	20.1
E.	72.5	4.5	13.9	25.7	61.6	10.4	9.2	18.8
F.	73.3	4.3	12.53	20.4	69.6	3.6	6.9	19.9

Both the Fischer-Schrader and Gray-King methods are still in use by coal laboratories in many countries. Recently, the former method was adopted by the International Standards Organization for determining the yields of tar, water, gas, and coke-residue by low-temperature distillation from brown coals and lignites (ISO standard 647-1974 [E]). The Gray-King method was adopted for determining the caking qualities of bituminous coals (ISO standard 502-1974 [E]).

As presently used, the two methods employ similar product recovery equipment, but differ in dimensions and construction of the retort, as well as in experimental procedure. The principal features of both methods are compared in table 5.

Pyrolysis test results from Fischer-Schrader and Gray-King analyses are found to be generally comparable, even though the methods have a number of differences, each of which

TABLE 4b.
Pyrolysis Data of Alberta Coals, Provenance Unknown:
Pyrolysis Gas Composition

Sample Designation	Gas Yield, mL/100 g daf coal*	Calorific Value Btu/cu ft	(Percent of Total Gas Produced)						
			Hydrogen	Carbon monoxide	Carbon dioxide	Methane	Ethane	Propane	Ethylene
A.	17454	423	20.3	20.0	34.0	23.9	1.2	0.4	0.2
B.	14652	395	16.0	22.0	35.0	24.8	1.4	0.5	0.2
C.	13800	554	21.0	17.3	19.9	37.3	2.9	0.8	0.8
D.	18062	414	16.8	22.8	33.3	25.0	1.4	0.5	0.2
E.	15510	381	17.0	21.3	36.1	23.7	1.4	0.4	0.1
F.	16643	371	17.6	19.8	38.4	22.4	1.3	0.4	0.1

* including N₂ and O₂.

TABLE 5.
Assay Methods for Coal Pyrolytic Properties Compared

Method	Fischer-Schrader	Gray-King
Retort Material	Aluminum	Glass or Transparent Silica
Retort Dimensions	170 mL vol. (± 10 mL)	20 mm in diameter X 300 mm long
Furnace	Electric or Gas	Electric
Sample Size	50 - 150 g	20 g
Initial Temperature, °C	ambient	325
Final Temperature, °C	520 - 550	600
Heating Rate, °C/min	6.5	5
Reaction Time	1.5 hr	1 hr
Gas Yield Determination	by difference: (gas% + error = 100 - char % - tar % - gas liquor %)	by collecting total gas product over brine (adjusted to atmospheric pressure) in a gas holder.

could conceivably affect the quality and quantity of pyrolysis product. Some of the differences, however, compensate for each other, and variation in product yield is relatively small over the range of 500 to 600°C within which both test methods, as well as all LTC processes, are confined.

The sixteen samples reported previously by Davies *et al.* (1961; see table 1) were assayed in Fischer-Schrader equipment as modified by Goodman *et al.* (1953), but with

the final temperature held at 600°C.

The remaining thirty-five samples, reported here for the first time (see tables 2, 3 and 4), were assayed in a conventional Gray-King retort. Yields of liquid products were determined by weighing condenser-train components before and after each run. Water-yield was determined by distilling, with toluene, the contents of the condenser-train trap fitted with a Stark-Dean moisture receiver.

RESULTS

Pyrolysis data for the first group of coal samples, the sixteen coals assayed in the modified Fischer-Schrader apparatus and reported by Davies *et al.* (1961), are given in table 1 (the unpyrolyzed coal analysis data here are drawn from previously unpublished files of the Alberta Research Council). Pyrolysis data for the other thirty-five samples, assayed in the Gray-King apparatus and reported here for the first time, are given in tables 2, 3 and 4. All of the results are averages of duplicate or triplicate runs, the mass balances of which agree within 0.5 percent.

Davies *et al.* (1961) compared the product yields of their samples with similar data from the United States; their comparison diagram is included here as figure 2. It may be observed that subbituminous coals generally yield rather small quantities of tar and light oils, with the yield at a minimum in the subbituminous B rank. Very high-ranking coals (medium and low volatile bituminous) also generally yield small quantities of tar and light oils but, on the other hand, high volatile bituminous coals afford significantly large quantities of these products. In general, Alberta coals of all ranks yield less tar and light oils than their United States counterparts, but yield more water and gas.

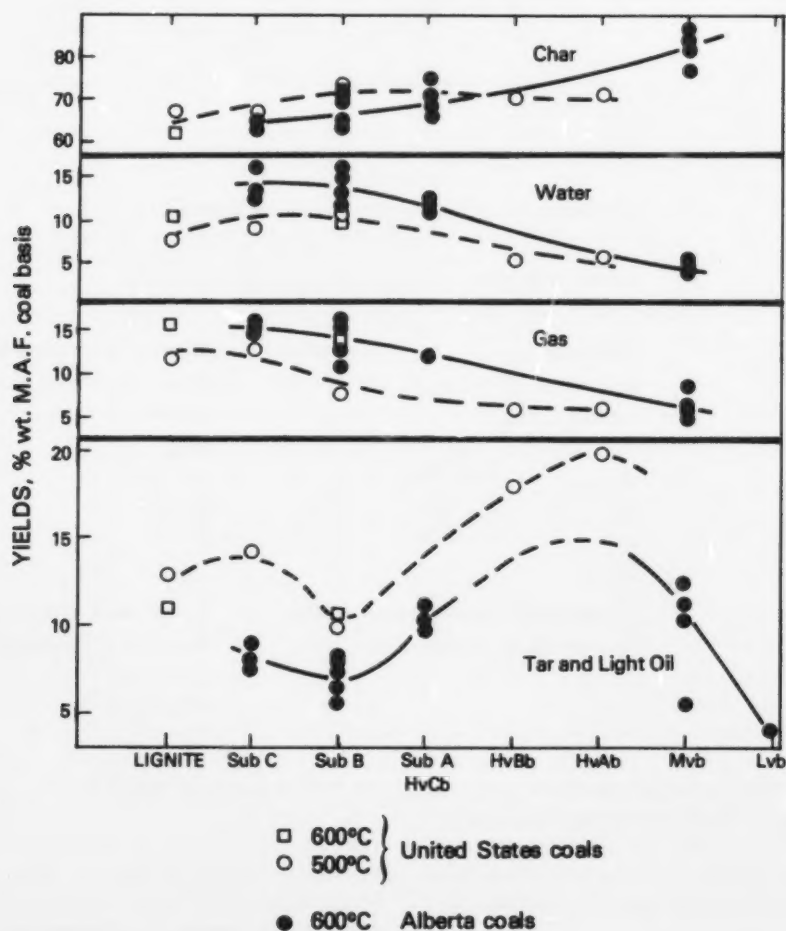


FIGURE 2. Variation of product yields with coal rank (from Davies *et al.* (1961))

Davies *et al.* (1961) were able to demonstrate over-all product yield trends in their comparison diagram (figure 2) by subjectively lumping the samples along the X-axis according to their coal ASTM rank. Significant differences between individual coals, however, are lost by lumping; these are better displayed by arranging the samples according to their capacity moisture (see figure 3).

Capacity moisture, a measure of a coal's moisture-holding capability, varies approximately with ASTM rank, and is a reliable objective parameter. It depends on, and is therefore

a quantitative indicator of, certain surface characteristics of coals, such as pore size distribution and chemical structure. In figure 3, pyrolysis data from all sample-groups have been plotted against capacity moisture so that new trend-relationships become apparent.

In figures 3a and 3b, data from the Fischer-Schrader assays (Davies *et al.*, 1961) have been plotted separately from the Gray-King assay data; as noted above, the two analytical methods provide different, yet readily comparable, results.

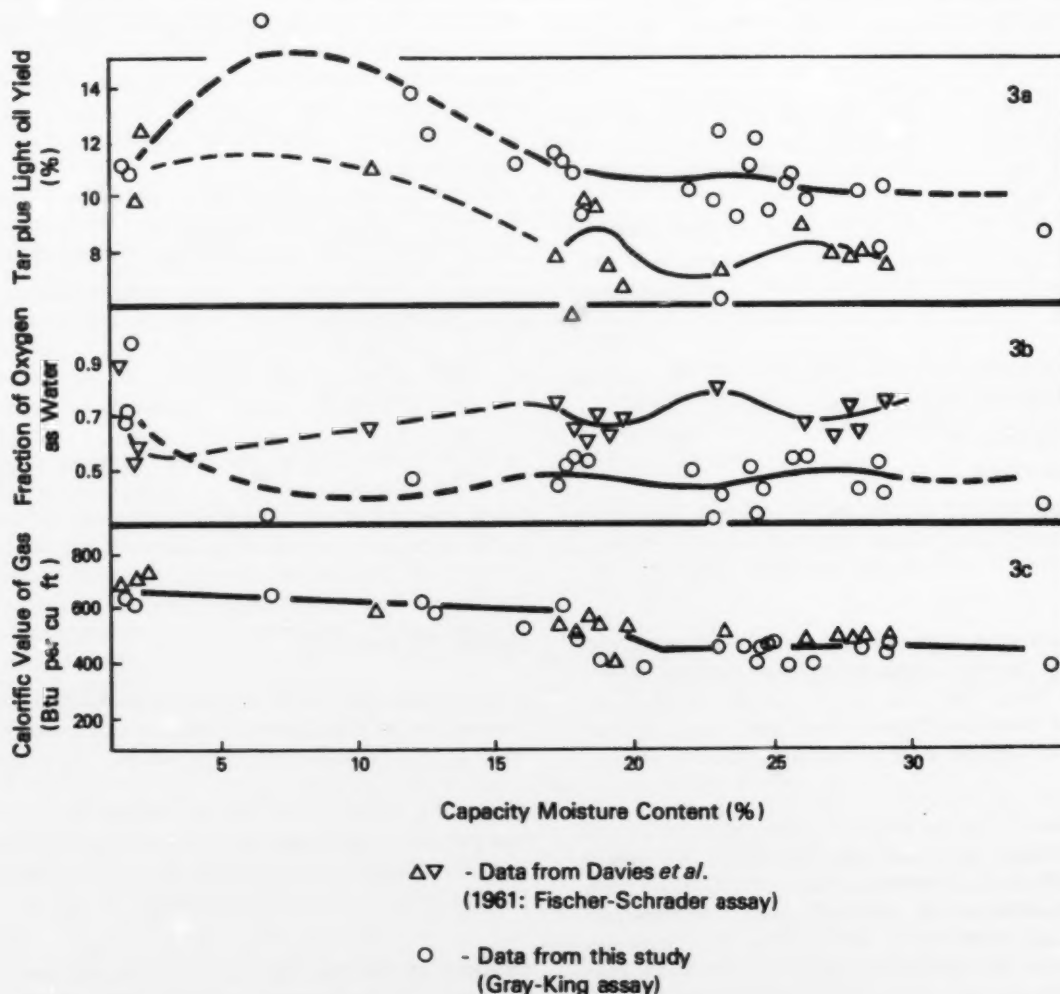


FIGURE 3. Pyrolysis data plotted against capacity moisture.

Comparison of the graphs in figure 3a (yields of tar and light oils plotted against capacity moisture) with those in figure 3b (the fraction of coal-oxygen content that yields reaction water) discloses that the former are mirror images of their counterpart graphs in figure 3b, the parameters of both being on the rank in some way. Apparently, the greater the loss of coal-oxygen in the form of water, the less tar and light oils are formed. Thus, the cleavage of C-O bonds and the mobility of nearby hydrogen seem to be important features of the chemistry of coal pyrolysis, playing key roles in determining the respective yields of tarry liquids and water. These reactions, however, may vary appreciably in magnitude from coal to coal, even within the same rank.

Gas production by coal pyrolysis also appears to depend on the rank. In figure 3c, calorific values of pyrolysis gases are

The yields and compositions of gases from pyrolysis of a coal may thus be predicted, at least in a general way, if the rank of the coal is known.

It may be questioned whether the variation of coal pyrolytic properties from deposit to deposit is systematic. To investigate this question, six component-samples of a single channel-sample across the closely associated seams 1 and 2 of Highvale Mine (Sec 7 Tp 52 R4 W 5 Mer) were assayed separately and in various combinations. The assay data are presented in table 3. While there are some mildly anomalous relationships (for example, the midsection samples of seams 1 and 2 revealed similar tar yields but somewhat different water yields), in general it may be concluded that local variations are not at all significant.

TABLE 6.
Generalized Pyrolysis-Gas Characteristics of Coals

Coal Rank	Gas Yield: Litres (STP) per 100 g daf. Coal	Gas Composition: volume %		
		H ₂	Oxides of Carbon	Light Hydrogen
Low + Medium volatile Bituminous	9 - 10	35	7	58
High volatile Bituminous/Subbituminous A	12 - 14	22	35	43
Subbituminous B	14 - 15	23	42	35
Subbituminous C	15 - 16	23	43	34

plotted against capacity moisture of their precursor coals. Apparently, there is a stepwise transition from the heating values of higher-rank coals (about 600 Btu per cu ft for bituminous coals) and those of lower-rank coals (between 400 and 500 Btu per cu ft for subbituminous C coals).

Composition of coal pyrolysis-gas is also influenced by coal rank (see tables 1b, 3b and 4b). Percentages of oxides of carbon (CO and CO₂) are much lower from bituminous coals than from subbituminous, while hydrogen and methane percentages are much higher. On the other hand, total gas yields tend to be considerably lower from bituminous than from subbituminous coals. The characteristics of coal pyrolysis-gas production are presented in generalized fashion in table 6.

UNKNOWN SAMPLES

Analyses of the six Alberta samples of essentially unknown provenance are given in table 4; these were included in this study to test the usefulness of the method.

Davies *et al.* (1961) noted that tar and light oils yield from coal pyrolysis is adversely affected by prior oxidation of the coal. The distinctively low product-yields of samples A and B (table 4) are likely due to weathering.

Oxidation of the coal also changes the yield and composition of the pyrolysis gas, actually increasing the yield (Davies *et al.*, 1961). Apparently, oxidation affects the structural moieties responsible for generating hydrogen and

hydrocarbons; the increase in gas yield reflects increasing production of oxides of carbon generated from partially oxidized C-H-structures.

Because of the high gas yields with high percentages of oxides of carbon from coals whose rank is known, we conclude that five of the six unknown samples (excluding sample C) have been oxidized by weathering.

The assay of pyrolytic properties shows promise of providing a useful tool for localizing unknown samples; more experience and a larger background of known assays are needed to realize the full potential of this method.

CONCLUSIONS

Alberta coals show the same general relationship between pyrolytic properties and rank as do United States coals, but tar and light oils yields are significantly lower in the former.

Pyrolysis product yields, especially yields of tar and light oils, and of water, vary somewhat within each coal rank; on a dry ash-free basis, tar and light oils yields are as follows:

low volatile bituminous:	3 to 4 percent;
medium volatile bituminous:	10 to 12 percent;
high volatile C bituminous:	10 to 16 percent;
subbituminous A and B:	4 to 13 percent; and
subbituminous C:	4 to 10 percent.

High tar and light oils yields are associated with low water yields and vice versa; this relationship is believed to be governed by the nature of the structural components of the precursor coal. High volatile bituminous coals, which afford the best pyrolysis-product yields, are also most satisfactory as feedstocks for hydroliquefaction processes and for short-residence-time pyrolysis processes. A few selected subbituminous coals may also be satisfactory for liquid production by pyrolysis.

Fischer-Schrader or Gray-King assay techniques can be used as a guide in selecting coal feedstocks for conversion processes.

Oxidized or weathered coals should be avoided for conversion.

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